Tutorial 3

1.

During heat treatment, cylindrical pieces of 25mm diameter, 30 mm height and at 30 ^{0}C are placed in a furnace at 750^{0}C with convection coefficient 80 W/ m^2 ^{0}C the surface. Calculate the time required to heat the pieces to 600 ^{0}C. What will be the shortfall in temperature if the pieces are taken out from the furnace after 280 seconds? Assume the following property values: density = 7850 kg/m^3; c= 480 J/kg-K; k= 40 W/ m ^{0}C.

2.

A fluid flows over a heated horizontal plate maintained at temperature T_w. The bulk temperature of the fluid is T_∞. The temperature profile in the thermal boundary layer is given by:

$$T = T_w + (T_w - T_\infty)\left[\frac{1}{2}\left(\frac{y}{\delta_t}\right)^3 - \frac{3}{2}\left(\frac{y}{\delta_t}\right)\right], \quad 0 \le y \le \delta_t$$

Here y is the vertical distance from the plate, δ_t is the thickness of the thermal boundary layer and k is the thermal conductivity of the fluid.
The local heat transfer coefficient is given by

3.

Example 2.8

An air temperature probe may be analysed as a fin. Calculate the temperature recorded by a probe of length L = 20 mm, k = 19 W/m K, D = 3 mm, when there is an external heat transfer coefficient of h = 50 W/m^{2}K, an actual air temperature of 50°C and the surface temperature at the base of the probe is 60°C.